Some Theoretical Aspects of a "Linear Collider" Open-Ended Fusion Power System

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This paper represents continued studies of a concept discussed in a previous Sherwood Theory conference [1]. The idea is to permit the achievement of useful net fusion power by the combination of high-efficiency ion sources, injecting into a linear solenoid reaction region, followed by a multi-stage direct converter. The efficiency of such a direct converter is inversely proportional to the energy spread of the captured ions. However, the probability of fusion and the energy spread (about the instantaneous mean) induced in an energy-modulated beam both scale in the same way with the interaction time. Thus net fusion power can in principle be achieved with small fractional burnups, provided injector efficiencies are high. As a specific example of such a system we consider a "linear collider" wherein two dissimilar-energy, co-propagating, energy-modulated, ion beams are injected into a long, graded-field, solenoidal magnetic field the highest intensity region of which coincides with the bunching distance of the beam. In this way both magnetic convergence and klystron-like bunching act to compress the beam ions to high density in the central region of the solenoid, so that "one-pass" net fusion power becomes a theoretical possibility. The main plasma physics issues here concern the possibility of beam-induced instabilities and the physics of the electron cloud in interaction with the beams. In the paper a preliminary analysis of the beam kinetics and of these instability and electron physics issues is presented.

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[1] R. F. Post, "Exploring the Limits of the 'Low Q' Fusion Power Regime", paper 1D18, in: Proceedings of the Sherwood International Fusion Conference, 14-16 March 1994.